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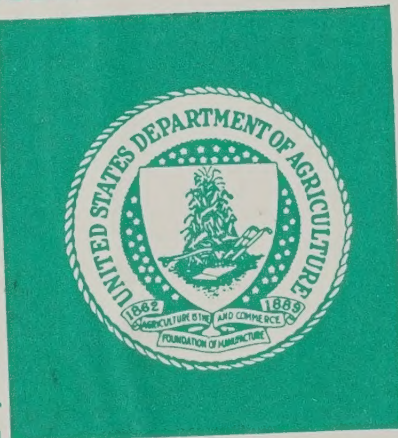
FUNGICIDE BENEFITS ASSESSMENT

National Agricultural Pesticide Impact Assessment Program (NAPIAP)

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FUNGICIDE BENEFITS ASSESSMENT

TURF

January, 1991

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This Report Represents a Portion of the USDA/States
National Agricultural Pesticide Impact Assessment Program (NAPIAP)
Fungicide Assessment Project

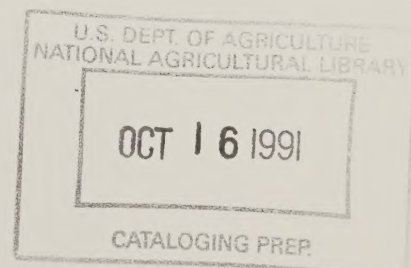


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PREFACE

Plant diseases affect all the major food crops world-wide and must be controlled to prevent significant production losses and maintain food quality for animals and humans. In addition, fungicides are a necessary factor in maintaining the availability of fiber and landscape improvements ranging from forest management to enhancements through the use of ornamentals. Agricultural fungicides are a significant component in effective disease control and are critical to plant health management systems. Fungicides provide benefits to producers as well as consumers and to local as well as national economies. Farmers benefit from the prevention of yield losses, improved crop quality, enhanced market opportunities, facilitation of farmwork and harvest. Consumers also benefit from an ample, varied, safe, healthy and inexpensive food supply that is available throughout the year.

This is one of 11 separate reports that assessed the beneficial aspects of fungicide use in U.S. agriculture. The 11 reports, all using a commodity approach in evaluating fungicide use, comprise the Fungicide Benefits Assessment. This assessment represents one part of the USDA/States National Agricultural Pesticide Impact Assessment Program's Fungicide Assessment Project. The two other parts deal with (a.) a treatise examining the health and environmental factors associated with the agricultural use of fungicides, and (b.) an assessment of the status as well as the management strategies for fungal resistance to fungicides in the U.S.

The 11 Fungicide Benefits Assessment reports were prepared by a team of scientists (team leaders). The team leaders and the listing of their reports (by commodity) in the Fungicide Benefits Assessment are as follows:

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Appreciation is extended to members of the Planning Committee and many other collaborators who gave generously of their time and expertise in helping develop the project, reviewing report drafts, providing information and preparation of the various reports.

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Charles R. Curtis, Project Director
Nancy N. Ragsdale, Coordinator Representing the USDA

January, 1991

Assessment of Fungicide Use on Turf

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INTRODUCTION

The basis of this assessment report is a marketing study purchased from an international consulting company. The data in the marketing study were collected from August 1988 through February 1989 and represent more than 600 interviews with appropriate individuals from 150 golf courses, 150 lawn care operators, 100 educational facilities, 100 landscaping businesses, 50 parks, 50 turf farms, and 25 cemeteries.

Additional information for the assessment process was obtained from product labels and appropriate plant pathology literature. The data in the tables were reviewed with the individuals listed in Table 1. In many instances, input from these individuals added to the data base. Common fungal turf diseases and the causal organisms are listed in Table 2. A total of 3,367,000 pounds and 649,000 gallons of fungicide product was used on turf in 1988 (Table 3).

This report is organized by the end user of fungicides labeled for turf. For example, lawn care operators apply a large part of the fungicides that are used on residential, industrial, and commercial turf. Landscaping businesses also use fungicides to control turf diseases in many of the same situations as lawn care operators. The amount of fungicide applied to these types of turf by individuals other than lawn care operators or landscaping businesses is probably minute.

The potential losses from turf diseases are extremely difficult to estimate. In this report, the only subcommodity group that might be able to quantify losses in the traditional sense are turf farms. Based on the relatively small amount of fungicides used and acres treated, diseases must be considered as a minor problem. In all other types of turf, losses would be in aesthetic value. For these reasons, disease losses are not discussed in this report. Essentially 100% of the fungicides are applied as a foliar spray (FS).

LAWN CARE OPERATORS

Lawn care operators include those companies that apply fertilizers and pesticides to residential, industrial, and commercial turf for the general purpose of increasing the aesthetic quality of the turf. Companies in this category do not perform other maintenance chores such as mowing, seeding, etc. In this report, these operations are considered to be carried out by landscaping firms.

Potentially, there are approximately 13.4 million acres of turf in the United States that could be under contract to lawn care operators. About 2.0 million acres of turf are under contract to lawn care operators. Of this area, 69,000 acres received at least one fungicide treatment in 1988. Some areas were treated more than once; consequently, 224,000 acre-treatments of fungicides were applied to these 69,000 acres.

The marketing study identified dollar spot as the most common fungal disease that lawn care operators attempt to control. Approximately 75% of the respondents mentioned this disease. Brown patch, leaf spot, pythium, snow mold, and fusarium were all mentioned less than 10% of the time. Brown patch, dollar spot, and fusarium, in that order, were noted as the most difficult to control.

The primary fungicides used by lawn care operators are shown in Table 4. In addition, this table shows the formulations available and the rates used. The diseases controlled as well as the alternative fungicides available for use are listed also. (Refer to Table 5 for a listing of alternative chemicals.) Chlorothalonil is the most widely used chemical by lawn care operators (Table 6). Chlorothalonil and iprodione account for about 84% of the fungicides used by these companies.

Most of the diseases targeted by lawn care operators can be controlled by a broad spectrum of fungicides. Fungicide resistance is probably not a great concern in this area of turf disease control but the broad spectrum of fungicides is used as a precaution to this problem.

GOLF COURSES

For purposes of this report, all types of golf course turf are considered collectively. There are approximately 13,470 golf courses containing 1,350,000 acres in the United States. Slightly over 50% of the area is fairways while 3-3.5% is greens and tees. Golf courses account for approximately 62 and 72% of the dry and liquid formulations, respectively, of the fungicides used on turf (Table 3).

Over 95% of the greens acreage and over 45% of the tee acreage were treated with a fungicide in 1988. Slightly less than 20% of the fairway acreage was treated, and only about 3% of the roughs received a fungicide application. Although greens and tees constitute only 3-3.5% of the total golf course acreage, they receive 287,000 acre-treatments on 47,000 acres of turf. On a nationwide basis, greens and tees were treated with fungicide five to ten times during 1988.

Dollar spot is clearly the most common disease on golf course turf. Brown patch and pythium are the only other diseases that were named by more than 5% of the individuals surveyed in the marketing study. Dollar spot and brown patch are the most difficult to control.

The eight most common fungicides used on golf courses are listed in Table 7. Chlorothalonil, iprodione, propamocarb, and metalaxyl account for 79% of the total amount of fungicidal active ingredients used on golf courses. Approximately 2.7 million pounds of active ingredients were used on golf courses in 1988. Chlorothalonil was applied in 232,000 acre-treatments and accounts for 40% of the total acre-treatments. Iprodione and triadimefon were applied in slightly less than 20% of the total acre-treatments.

There are a wide number of fungicides available for controlling the diseases most commonly encountered on golf courses (Table 8). Since disease pressure is frequently very high, particularly on greens and tees, applications are made throughout the growing season. Essentially, all of the diseases listed are potential problems on any golf course. Losses due to diseases on golf courses have not been estimated in terms of yield as with most other crops but would have to be measured in terms of aesthetic value. Courses with severe disease problems could expect to lose revenue from a reduced number of players. In some instances, there could be the cost of replacing the turf.

The wide number of fungicides available to control most diseases allows applicators the flexibility of using fungicides with differing modes of action in order to manage fungicide resistance in pathogen populations.

LANDSCAPING BUSINESSES

Landscaping businesses are generally considered as those firms that maintain turf. Lawn care operators usually only apply chemicals (fertilizers and pesticides) while landscaping businesses provide a much broader range of services including turf establishment and mowing plus other maintenance operations. The potential acreage for landscaping businesses is the same as for lawn care operators, namely 13.4 million acres.

Thirteen percent of the dry formulations and 2% of the liquid formulations of fungicide used on turf are applied by landscaping businesses (Table 3). Iprodione accounts for about 36% of the active ingredient used while benomyl and chlorothalonil account for 9% and 6%, respectively, of the material applied (Table 9). Landscaping businesses apply fungicides to 130,000 acre-treatments (Table 9) with a total of 72,000 acres treated.

Essentially the same fungicides used by lawn care operators and by golf courses are used by landscaping businesses (Table 10). The diseases controlled are the same also. Iprodione, benomyl, and chlorothalonil account for 50% of the fungicides used by landscaping businesses (Table 9).

EDUCATIONAL FACILITIES

Turf maintained by educational facilities is primarily athletic fields. There are potentially 1.8 million acres available for application of fungicides. In 1988, approximately 109,000 pounds of active ingredients were applied in 28,000 acre-treatments (Table 11).

The fungicides used and the diseases controlled on athletic fields are similar to the other categories of turf (Table 12). Chlorothalonil constitutes 57% of the active ingredient used in this category of turf. Brown patch is the most common disease on this type of turf followed by dollar spot, pythium, and snow mold. Other diseases such as leaf spots, fusarium, copper spot, helminthosporium, and fairy ring are minor problems that receive some attention.

TURF FARMS

Turf farms consist of commercial enterprises that grow sod for replanting on residential, public, industrial, and commercial property. About 275,000 acres of sod are grown on approximately 1,300 turf farms in the United States. Nearly 14,000 pounds and 11,000 gallons of dry and liquid fungicide formulations, respectively, were used in sod production in 1988 (Table 3). This material was applied to 15,000 acres in 27,000 acre-treatments (Table 13).

The fungicides normally used by turf farms are shown in Table 14 along with the rates used and the diseases controlled. This information is essentially the same as for the other categories of turf. Chlorothalonil accounts for 56% of the total amount of fungicide active ingredients used in 1988 (Table 13). Other active ingredients used are metalaxyl, triadimefon, benomyl, and iprodione. The diseases requiring fungicide treatment on this type of turf are similar to the other types. Overall, fungicide use in sod production accounts for only a small portion of the total amount of fungicides used on all types of turf.

SEED PRODUCTION

Nearly all of the turf seed production in the United States is concentrated in three states; namely, Idaho, Oregon, and Washington. Production figures were difficult to obtain. Some data was available through seed certification agencies in these states. The acreage data in Table 15 does not represent all of the acreage devoted to turf grass seed production. For example, in Oregon in 1988, 343,060 acres of seed were harvested while approximately 190,680 (1989 data) were passed for certification. The figure for Idaho and Washington represents only the acreage passed for certification. For Washington, it is estimated that only 25% of the total acreage grown is accepted or submitted for certification.

The major disease problem for seed production is stem rust on perennial rye grass and tall fescue. In Oregon, essentially 100% of the acreage is infected and 100% of the acreage receives at least one fungicide treatment. Commonly, seed production fields of these two species are treated two to four times per season with propiconazole. Powdery mildew is important in bluegrass seed production with approximately 5% of the acreage treated at least once per season. Triadimefon is the active ingredient most often used for the control of powdery mildew. Propiconazole is effective as an alternative but triadimefon is preferred.

SEED TREATMENTS

Only a small portion of the turf seed produced is treated with a seed treatment. We were unable to obtain estimates on the amount treated or the acreage which is planted with treated seed. Fungicides labeled as seed treatments are shown in Table 16. Nearly all of the treated seed is used in the South.

<u>TABLE NUMBER</u>	<u>DESCRIPTION OR CONTENT</u>
1	Contributors
2	Common turf diseases
3	Fungicide consumption by end user
4	Subcommodity:lawn care operators (LCOs)
5	Codes for alternative chemicals
6	Lbs of a.i. & acre-treatments for LCOs
7	Lbs. of a.i. & acre-treatments for golf courses
8	Subcommodity:golf courses
9	Lbs. of a.i. & acre-treatments for landscaping businesses
10	Subcommodity:landscaping businesses
11	Lbs. of a.i. & acre-treatments for educational facilities
12	Subcommodity:educational facilities
13	Lbs. of a.i. & acre-treatments for turf farms
14	Subcommodity:turf farms
15	Subcommodity:seed production
16	Subcommodity:seed treatments

Table 1. Contributors to turf fungicide assessment process.

NAME	AFFILIATION
Patricia L. Sanders	The Pennsylvania State University
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Richard Smiley	Oregon State University
Douglas Boze	Washington Department of Agriculture

Table 2. Common turf diseases.

<u>COMMON NAME</u>	<u>CAUSAL ORGANISM</u>
Dollar Spot	<u>Sclerotinia homoeocarpa</u>
Brown Patch	<u>Rhizoctonia solani</u>
Fusarium Patch (Pink Snow Mold)	<u>Gerlachia nivalis</u>
Fusarium Blight	<u>Fusarium</u> spp.
Typhula Blight (Gray Snow Mold)	<u>Typhula incarnata</u> <u>Typhula ishikariensis</u>
Copper Spot	<u>Gloeocercospora sorghi</u>
Leaf Spots:	
Gray Leaf Spot	<u>Pyricularia grisea</u> <u>Pyricularia oryzae</u>
Helminthosporium Leaf Spot	<u>Helminthosporium</u> spp.
Curvularia Leaf Spot	<u>Curvularia</u> spp.
Alternaria Leaf Spot	<u>Alternaria</u> spp.
Pythium Blight	<u>Pythium</u> spp.
Pythium Damping Off	<u>Pythium</u> spp.
Helminthosporium leaf, crown and root diseases	<u>Helminthosporium</u> spp.
Anthracnose	<u>Colletotrichum graminicola</u>
Corticium Red Thread	<u>Laetisaria fuciformis</u>
Powdery Mildew	<u>Erysiphe graminis</u>
Downy Mildew (Yellow Tuft)	<u>Sclerophthora macrospora</u>
Stripe Smut	<u>Ustilago striiformis</u>
Summer Patch	<u>Magnaporthe poae</u>
Spring Dead Spot Necrotic Ring Spot	<u>Leptosphaeria korrae</u>
Southern Blight	<u>Sclerotium rolfsii</u>

Table 2. (continued)

COMMON NAME

CAUSAL ORGANISM

Take-All-Patch

Gaeumannomyces graminis

Rust

Puccinia and Uromyces spp.

Table 3. Fungicide consumption by end user.

User	Consumption (x 10 ³)	
	lb.	gal.
Lawn care operators	714	149
Golf courses	2,080	46
Landscaping businesses	446	11
Educational facilities	113	11
Turf farms	14	11
TOTAL	3,367	649

Table 4.
Subcommodity: Lawn Care Operators
Potential Acres for Treatment: 13,370,000
Acres Treated: 69,000
Acre-Treatments: 224,000

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method	Alternative chemicals ⁴
Chlorothalonil	75% WP	Dollar Spot	1.6 - 16.3	M(7-21D)	100% FS	A,B,D,E,F,G,I,J,K,K1,K2,K3,M
	40.4% L	Brown Patch	3.2 - 16.3	M(7-14D)	100% FS	A,B,D,E,F,I,J,K K1,K2,K3,L,S
	90% WDG	Leaf Spot	3.2 - 16.3	M(7-21D)	100% FS	A,E,F,I,K1,K2
		Gray Snow Mold	8.8 - 22.5	M(30D)	100% FS	A,D,E,I,J,O
		Fusarium Patch	8.8 - 20.4	M(21-28D)	100% FS	B,D,E,I,J,K3,M
		Others	varies	varies	100% FS	varies
Propiconazole	14.3% L	Dollar Spot	0.2 - 0.8	M(7-28D)	100% FS	A,B,C,D,E,F,G,J,K,K1,K2,K3,M
		Brown Patch	0.8 - 1.6	M(10-21D)	100% FS	A,B,C,D,E,F,J,K,K1,K2,K3,L,S
		Leaf Spot	0.7 - 1.6	M(14D)	100% FS	A,C,E,F,K1,K2
		Gray Snow Mold	1.6	1X	100% FS	A,C,D,E,J,O
		Fusarium Patch	1.6	1X	100% FS	B,C,D,E,J,K3,M
		Others	varies	varies		varies
Metalaxyl	25.1% WP	Pythium	0.7 - 1.4	3 (7-21D)	approx. 100% FS ³	F,O,P,Q,R
	2% G	Others	varies	varies		varies
Iprodione	50% WP	Dollar Spot	1.3 - 2.7	M(14-28D)	100% FS	A,B,C,D,F,G,I,J K,K1,K2,K3,M
	23.3% L	Brown Patch	1.4 - 2.7	M(14-28D)	100% FS	A,B,C,D,F,I,J,K K1,K2,K3,L,S
		Gray Snow Mold	2.5 - 5.5	1X	100% FS	A,C,D,I,J,O
		Helminthosporium	1.4 - 2.7	M(14-28D)	100% FS	C,D,I

Table 4 - continued

Chemical	Formulation ¹	Diseases controlled	Rate (a.l./A)	No. of applications (Interval between applications) ²	Method	Alternative chemicals ³
Benomyl	50% WP	Fusarium Patch	2.5 - 5.5	M(14-21D)	100% FS	B,C,D,I,J,K3,M
		Fusarium Blight	5.1 - 5.5	3X(14-21D)	100% FS	B,D,F,J
		Others	varies	varies		varies
		Dollar Spot	1.4	M(10-14D)	100% FS	
		Brown Patch	2.7	M(5-14D)	100% FS	
		Fusarium Patch	2.7	M(10-14D)	100% FS	C,D,E,I,J,K3,M
		Fusarium Blight	6.8 - 11.0	M(10-14D)	100% FS	D,E,F,J
		Helminthosporium	4.1 - 5.4	2-3X(7-10D)	100% FS	
		Others	varies	varies		varies

1 WP=wettable powder; L=liquid or flowable; WDG=water-dispersable granular; G=granular

2 M=many; D=days; X=times

3 Metalaxyl is rarely used in the granular (G) form

4 Refer to Table 5.

Table 5. Code for fungicides listed as alternative chemicals in Tables 4, 8, 10, 12, and 14.

CODE	CHEMICAL
A	Anilazine
B	Benomyl
C	Chlorothalonil
D	Fenarimol
E	Iprodione
F	Mancozeb
G	Maneb
H	PCNB
I	Propiconazole
J	Triadimefon
K	Thiophanate
K1	Thiophanate-M+Iprodione
K2	Thiophanate-M+Mancozeb
K3	Thiophanate-methyl
L	Thiram
M	Vinclozolin
N	Metalaxyl
O	Chloroneb
P	Etridiazole
Q	Phosethyl-Al
R	Propamocarb
S	Captan

Table 6. Pounds of active ingredient (a.i.) and acre-treatments (A-T) with fungicides by lawn care operators.

Chemical	lb. a.i. (x 10 ³)	A-T (x 10 ³)
Chlorothalonil	484	88
Iprodione	396	63
Metalaxyl	53	26
Benomyl	15	15
Propiconazole	2	6
All Others	102	26
TOTAL	1,052	224

Table 7. Pounds of active ingredient (a.i.) and acre-treatments (A-T) with fungicides by golf courses.

Chemical	lb. a.i. (x 10 ³)	A-T (x 10 ³)
Chlorothalonil	1,480	232
Iprodione	280	96
Propamocarb	218	--
Metalaxyl	120	40
Propiconazole	60	--
Triadimefon	35	93
Benomyl	24	--
Fenarimol	18	14
All others	430	85
TOTAL	2,665	560

Table 8.

Subcommodity: Golf Courses

Potential Acres for Treatment: 1,350,000

Acres Treated: 180,900

Acre-Treatments: 560,000

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method	Alternative chemicals ⁴
Chlorothalonil	75% WP	Dollar Spot	1.6 - 16.3	M(7-21D)	100% FS	A,B,D,E,F,G,I,J K,K1,K2,K3,M
	40.4% L	Brown Patch	3.2 - 16.3	M(7-14D)	100% FS	A,B,D,E,F,I,J,K K1,K2,K3,L,S
	90% WDG	Leaf Spot	3.2 - 16.3	M(7-21D)	100% FS	A,E,F,I,K1,K2
		Gray Snow Mold	8.8 - 22.5	M(30D)	100% FS	A,D,E,I,J,O
		Fusarium Patch	8.8 - 20.4	M(21-28D)	100% FS	B,D,E,I,J,K3,M
		Copper Spot	6.6 - 12.1	M(7-10D)	100% FS	A,B,D,E,J,K,K3
		Others	varies	varies		varies
	14.3% L	Dollar Spot	0.2 - 0.8	M(7-28D)	100% FS	A,B,C,D,E,F,G,J K,K1,K2,K3,M
Propiconazole		Brown Patch	0.8 - 1.6	M(10-21D)	100% FS	A,B,C,D,E,F,J,K K1,K2,K3,L,S
		Leaf Spot	0.7 - 1.6	M(14D)	100% FS	A,C,E,F,I,K1,K2
		Gray Snow Mold	1.6	1X	100% FS	A,C,D,E,J,O
		Fusarium Patch	1.6	1X	100% FS	B,C,D,J,K3,M
		Others	varies	varies		
	25.1% WP	Pythium	0.7 - 1.4	3 (7-21D)	approx. 100% FS	F,O,P,Q,R
	2% G	Others	varies	varies		varies
	50% WP	Dollar Spot	1.3 - 2.7	M(14-28D)	100% FS	A,B,C,D,F,G,I,J K,K1,K2,K3,M
Metalaxyl						
Iprodione						

Table 8 - Continued

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method	Alternative chemicals ⁴
Benomyl	23.3% L	Brown Patch	1.4 - 2.7	M(14-28D) K1, K2, K3, L, S	100% FS	A, B, C, D, F, I, J, K
		Gray Snow Mold	2.5 - 5.5	1X	100% FS	A, C, D, I, J, O
		Helminthosporium	1.4 - 2.7	M(14-28D)	100% FS	C, F, I
		Fusarium Patch	2.5 - 5.5	M(14-28D)	100% FS	B, C, D, I, J, K3, M
		Fusarium Blight	5.1 - 5.5	3X(14-21D)	100% FS	B, D, F, J
		Others	varies	varies		varies
		Dollar Spot	1.4	M(10-14D)	100% FS	A, C, D, E, F, G, I, J K, K1, K2, K3, M
		Brown Patch	2.7	M(5-14D)	100% FS	A, C, D, E, F, I, J, K K1, K2, K3, L, S
		Fusarium Patch	2.7	M(10-14D)	100% FS	D, E, F, J
		Fusarium Blight	6.8 - 11.0	M(10-14D)	100% FS	C, D, E, I, J, K3, M
Triadimefon	25% WP	Helminthosporium	4.1 - 5.4	2-3X(7-10D)	100% FS	C, E, F, H, I
		Others	varies	varies		varies
		Dollar Spot	0.7 - 1.4	M(30-60D)	100% FS	A, B, C, D, E, F, G, I K, K1, K2, K3, M
		Brown Patch	0.7 - 1.4	M(15-30D)	100% FS	A, B, C, D, E, F, I, K K1, K2, K3, L, S
		Gray Snow Mold	2.7	1X	100% FS	A, C, D, E, I, O
		Fusarium Patch	1.4 - 2.7	M(30-60D)	100% FS	B, C, D, E, I, K3, M
		Fusarium Blight	0.7 - 1.4	M(15-30D)	100% FS	B, D, E, F
		Copper Spot	1.4 - 2.7	M(30D)	100% FS	A, B, C, D, E, K, K3
		Others	varies	varies	100% FS	varies
		Dollar Spot	0.2 - 0.5	M(10-30D)	100% FS	A, B, C, E, F, G, I, J K, K1, K2, K3, M
Fenarimol	11.6% WP	Brown Patch	0.5	M(7-14D)	100% FS	A, B, C, E, F, I, J, K K1, K2, K3, L, S

Table 8 - Continued

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method	Alternative chemicals ⁴
Propanocarb	66.5% L	Gray Snow Mold	2.5	1-2X	100% FS	A, C, E, I, J, O
		Fusarium Patch	2.5	1-2X	100% FS	B, E, F, J, K3, M
		Fusarium Blight	0.6 - 2.5	1X or M(30D)	100% FS	B, E, F, J
		Copper Spot	0.2 - 0.5	M(10-28D)	100% FS	A, B, C, E, J, K, K3
		Others	varies	varies		varies
Anilazine	38% L	Pythium	2.4 - 7.2	M(7-21D)	100% FS	F, N, O, P, Q
		Dollar Spot	4.1 - 8.3	M(10-14D)	100% FS	B, C, D, E, F, G, I, J, K, K1, K2, K3, M
		Brown Patch	4.1 - 8.3	M(10-14D)	100% FS	B, C, D, E, F, I, J, K, K1, K2, K3, L, S
		Leaf Spot	2.1 - 4.1	M(14-28D)	100% FS	C, E, F, I, K1, K2
		Gray Snow Mold	4.1	1-3X	100% FS	C, D, E, I, J, O
		Copper Spot	4.1 - 8.3	M(10-14D)	100% FS	C, D, J, K
		Others	varies	varies		varies

¹ WP=wettable powder; L=liquid or flowable; WDG=water-dispersable granular; G=granular

² M=many; D=days; X=times

³ Metalaxyl is rarely used in the granular (G) form.

⁴ Refer to Table 5.

Table 9. Pounds of active ingredient (a.i.) and acre-treatments (A-T) with fungicides by landscaping businesses.

Chemical	lb. a.i. (x 10 ³)	A-T (x 10 ³)
Iprodione	75	20
Benomyl	18	49
Chlorothalonil	13	5
Triadimefon	4	9
All others	100	47
TOTAL	210	130

Table 10.

Subcommodity: Landscaping Businesses

Potential Acres for Treatment: 13,370,000

Acres Treated: 72,000

Acre-Treatments: 130,000

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (interval between applications) ²	Method	Alternative Chemicals ⁴
Chlorothalonil	75% WP	Dollar Spot	1.6 - 16.3	M(7-21D)	100% FS	A, B, D, E, F, G, I, J, K, K1, K2, K3, M
	0.4% L	Brown Patch	3.2 - 16.3	M(7-14D)	100% FS	A, B, D, E, F, I, J, K, K1, K2, K3, L, S
	90% WDG	Leaf Spot	3.2 - 16.3	M(7-21D)	100% FS	A, E, F, I, K1, K2
		Gray Snow Mold	8.8 - 22.5	M(30D)	100% FS	A, D, E, I, J, O
		Fusarium Patch	8.8 - 20.4	M(21-28D)	100% FS	B, D, E, I, J, K3, M
		Others	varies	varies		varies
	25.1% WP	Pythium	0.7 - 1.4	3;(7-21D)	approx. 100% FS ³	F, O, P, Q, R
Iprodione	2% G	Others	varies	varies		varies
	50% WP	Dollar Spot	1.3 - 2.7	M(14-28D)	100% FS	A, B, C, D, F, G, I, J, K, K1, K2, K3, M
	23.3% L	Brown Patch	1.4 - 2.7	M(14-28D)	100% FS	A, B, C, D, F, I, J, K, K1, K2, K3, L, S
		Gray Snow Mold	2.5 - 5.5	1X	100% FS	A, C, D, I, J, O
		Helminthosporium	1.4 - 2.7	M(14-28D)	100% FS	C, F, I
		Fusarium Patch	2.5 - 5.5	M(14-21D)	100% FS	B, C, D, I, J, K3, M
		Fusarium Blight	5.1 - 5.5	3X(14-21D)	100% FS	B, D, F, J
		Others	varies	varies		varies

Table 10 - Continued

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method	Alternative chemicals ³
Benomyl	50% WP	Dollar Spot	1.4	M(10-14D)	100% FS	A, C, D, E, F, G, I, J, K, K1, K2, K3, M
		Brown Patch	2.7	M(5-14D)	100% FS	A, C, D, E, F, I, J, K, K1, K2, K3, L, S
		Fusarium Patch	2.7	M(10-14D)	100% FS	D, E, F, J
		Fusarium Blight	6.8 - 11.0	M(10-14D)	100% FS	C, D, E, J, K3, M
		Helminthosporium	4.1 - 5.4	2-3X(10-14D)	100% FS	C, E, F, H, I
		Others	varies	varies		varies
Triadimefon	25% WP	Dollar Spot	0.2 - 0.5	M(10-30D)	100% FS	A, B, C, E, F, I, K, K1, K2, K3, M
		Brown Patch	0.5	M(7-14D)	100% FS	A, B, C, E, F, I, K, K1, K2, K3, L, S
		Gray Snow Mold	2.5	1-2X	100% FS	A, C, D, E, I, O
		Fusarium Patch	2.5	1-2X	100% FS	B, E, F, K3, M
		Fusarium Blight	0.6 - 2.5	1X or M(30D)	100% FS	B, E, F
		Copper Spot	0.2 - 0.5	M(10-28D)	100% FS	A, B, C, D, E, K, K3
		Others	varies	varies		varies

¹ WP=wettable powder; L=liquid or flowable; WDG=water-dispersable liquid; G=granular

² M=many; D=days; X=times

³ Metalaxyl is rarely used in the granular form

⁴ Refer to Table 5.

Table 11. Pounds of active ingredient (a.i.) and acre-treatments (A-T) with fungicides by educational facilities.

Chemical	lb. a.i. (x 10 ³)	A-T (x 10 ³)
Chlorothalonil	60	10
Benomyl	15	8
Iprodione	14	5
Metalaxyl	7	2
All others	13	3
TOTAL	109	28

Table 12.

Subcommodity: Educational Facilities

Potential Acres for Treatment: 1,781,000

Acres Treated:

Acre-Treatments: 28,000

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method	Alternative chemicals
Chlorothalonil	75% WP	Dollar Spot	1.6 - 16.3	M(7-21D)	100% FS	A,B,D,E,F,G,I,J,K,K1,K2,K3,M
	40.4% L	Brown Patch	3.2 - 16.3	M(7-14D)	100% FS	A,B,D,E,F,I,J,K K1,K2,K3,L,S
	90% WDG	Leaf Spot	3.2 - 16.3	M(7-21D)	100% FS	A,E,F,I,K1,K2
		Gray Snow Mold	8.8 - 22.5	M(30D)	100% FS	A,D,E,I,J,O
		Fusarium Patch	8.8 - 20.4	M(21-28D)	100% FS	B,D,E,I,J,K3,M
		Copper Spot	6.6 - 12.1	M(7-10D)	100% FS	A,B,D,E,J,K,K3
		Others	varies	varies		varies
Metalaxyl	25.1% WP	Pythium	0.7 - 1.4	3 (7-21D)	approx. 100% FS	F,O,P,Q,R
	2% G	Others	varies	varies		varies
Iprodione	50% WP	Dollar Spot	1.3 - 2.7	M(14-28D)	100% FS	A,B,C,D,F,G,I,J K,K1,K2,K3,M
	23.3% L	Brown Patch	1.4 - 2.7	M(14-28D)	100% FS	A,B,C,D,F,I,J,K K1,K2,K3,L,S
		Gray Snow Mold	2.5 - 5.5	1X	100% FS	A,C,D,I,J,O
		Helminthosporium	1.4 - 2.7	M(14-28D)	100% FS	C,D,I
		Fusarium Patch	2.5 - 5.5	M(14-21D)	100% FS	B,C,D,I,J,K3,M
		Fusarium Blight	5.1 - 5.5	3X(14-21D)	100% FS	B,D,F,J
		Others	varies	varies		varies

Table 12 - Continued

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method	Alternative chemicals ³
Benomyl	50% WP	Dollar Spot	1.4	M(10-14D)	100% FS	A,C,D,E,F,G,I,J,K,K1,K2,K3,M
		Brown Patch	2.7	M(5-14D)	100% FS	A,C,D,E,F,I,J,K,K1,K2,K3,L,S
		Fusarium Patch	2.7	M(10-14D)	100% FS	C,D,E,I,J,K3,M
		Fusarium Blight	6.8 - 11.0	M(10-14D)	100% FS	D,E,F,J
		Helminthosporium	4.1 - 5.4	2-3X(7-10D)	100% FS	C,E,F,H,I
		Others	varies	varies		varies
Fenarimol	11.6% WP	Dollar Spot	0.2 - 0.5	M(10-30D)	100% FS	A,B,C,E,F,G,I,J,K,K1,K2,K3,M
		Brown Patch	0.5	M(7-14D)	100% FS	A,B,C,E,F,I,J,K K1,K2,K3,L,S
		Gray Snow Mold	2.5	1-2X	100% FS	A,C,E,I,J,O
		Fusarium Patch	2.5	1-2X	100% FS	B,E,F,J,K3,M
		Fusarium Blight	0.6 - 2.5	1X or M(30D)	100% FS	B,E,F,J
		Copper Spot	0.2 - 0.5	M(10-28D)	100% FS	A,B,C,E,J,K,K3
		Others	varies	varies		varies

¹ WP=wettable powder; L=liquid or flowable; WDG=water-dispersable granular; G=granular

² M=many; D=days; X=times

³ Metalaxyl is rarely used in the granular (G) form.

⁴ Refer to Table 5.

Table 13. Pounds of active ingredient (a.i.) and acre-treatments (A-T) with fungicides by turf farms.

Chemical	lb. a.i. (x 10 ³)	A-T (x 10 ³)
Chlorothalonil	26	15
Metalaxyl	2	3
All others	18	9
TOTAL	46	27

Table 14.

Subcommodity: Turf Farms

Potential Acres for Treatment: 275,000

Acres Treated: 15,000

Acres-Treatments: 27,000

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method	Alternative chemicals ⁴
Chlorothalonil	75% WP	Dollar Spot	1.6 - 16.3	M(7-21D)	100% FS	A,B,D,E,F,G,I,J K,K1,K2,K3,M
	40.4% L	Brown Patch	3.2 - 16.3	M(7-14D)	100% FS	A,B,D,E,F,I,J,K K1,K2,K3,L,S
	90% WDG	Others	varies	varies	varies	varies
Metalaxyl	25.1% WP	Pythium	0.7 - 1.4	3 (7-21D) approx.	100% FS ³	F,O,P,Q,R
	2% G	Others	varies	varies	varies	varies
Iprodione	50% WP	Dollar Spot	1.3 - 2.7	M(14-28D)	100% FS	A,B,C,D,F,G,I,J K,K1,K2,K3,M
	23.3% L	Brown Patch	1.4 - 2.7	M(14-28D)	100% FS	A,B,C,D,F,I,J,K D1,K2,K3,L,S
		Fusarium Blight	5.1 - 5.5	3X(14-21D)	100% FS	B,D,F,J
		Others	varies	varies	varies	varies
Benomyl	50% WP	Dollar Spot	1.4	(M10-14D)	100% FS	A,C,D,E,F,G,I,J K,K1,K2,K3,M
		Brown Patch	2.7	M(5-14D)	100% FS	A,C,D,E,F,I,J,K K1,K2,K3,L,S
		Fusarium Blight	6.8 - 11.0	3X(14-21D)	100% FS	D,E,F,J
		Others	varies	varies	varies	varies

Table 14 - Continued

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method	Alternative chemicals ^{3,4}
Triadimefon	25% WP	Dollar Spot	0.7 - 1.4	M(30-60D)	100% FS	A,B,C,D,E,F,I,K K1,K2,K3,M
		Brown Patch	0.7 - 1.4	M(15-30D)	100% FS	A,B,C,D,E,F,I,K K1,K2,K3,L,S
		Fusarium Blight	0.7 - 1.4	M(15-30D)	100% FS	B,D,E,F
		Others	varies	varies	varies	varies

¹ WP=wettable powder; L=liquid or flowable; WDG=water-dispersable granular; G=granular
² M=many; D=days; X=times
³ Metalaxyl is rarely used in the granular (G) form.
⁴ Refer to Table 5.

Table 15.

Subcommodity: Seed Production

Potential acres for treatment:

Oregon-343,060 ryegrass seed, bluegrass, fescue, & bentgrass (1988 figure)
 Washington-35,000 bluegrass, 4400 other (1987 figure)
 Idaho-14,319 Kentucky bluegrass and 178 turf-type tall fescue (1989 figure)

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./acre)	No. of applications (Interval between applications) ²	Method ³	Percent loss without treatment	Type of grass treated
Propiconazole	41.8% F	Powdery Mildew	maximum of 0.25 lbs. for bluegrass; 0.25 - 0.5 lbs for others	1-2X(14-21D)	FS and ground application	10-20% of bluegrass (5% of acreage is treated)	Bluegrass, perennial ryegrass, fescues, in OR, WA, & ID, only
		Rust		2-4X(14-21D) in Oregon; at least 1X in Washington & Idaho		40-100% of perennial ryegrass & tall fescue (100% of acreage is treated)	
Triadimefon	25% WP	Powdery Mildew	0.7 - 1.4 lbs	1-2X(15-30D)	100% FS	10-20%	Bluegrass

1 F=flowable; WP=wettable powder

2 X=times; D=days

3 FS=foliar spray

Table 16.

Subcommodity: Seed Treatments

Chemical	Formulation ¹	Diseases controlled	Rate (a.i./100 lbs.seed)	Method	Type of grass seed treated
Metalaxyl	28.35% F	Pythium damping off	0.4 - 1.0 fl.oz	Water-based slurry	Bermuda and ryegrass
	25% WP	Pythium seed rot	0.5 - 1.0 oz.	Mix with seed at planting	
Iprodione	12.5% D				
	30% F	Fusarium nivale Fusarium roseum Helminthosporium spp. Rhizoctonia spp. Sclerotinia homoeocarpa	0.9 - 1.8 fl.oz	Water-based slurry	various
Thiram	30% F 42% L 50% WP	Damping off, seedling blights, & seed decays caused by various seedborne and soilborne organisms	2.0 - 4.0 fl.oz.	Water-based slurry; (WP May be applied dry)	various
Captan	28.7% F 37.4% F	Seed rots, seed decays, seedling blights, & damping off caused by various seed borne organisms	1.9 - 3.1 fl.oz.	Water-based slurry	various
Etridiazole	71.7% WP		3.9 oz.	Water-based slurry	bluegrass
	40% WP	Damping off, root & stem rots caused by species of Fusarium, Pythium, Rhizoctonia, & others	0.1 - 1.6 oz.	Water-based slurry	various
	8% G			Mix with seed at planting	

¹ F=flowable; WP=wettable powder; D=dry; L=liquid; G=granular

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